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THE SOCIAL ADVANTAGES AND DISADVANTAGES OF THE ENGINEERING-SCIENTIFIC APPROACH TO CIVILIZATION[1]

By HENRY A. WALLACE

SECRETARY OF AGRICULTURE

I SUPPOSE you are all more or less familiar with that concept of the cyclical rhythm of civilization which has been popularized in recent years by Petrie, the Egyptologist, and Spengler, the German philosopher. According to this analysis, a civilization takes its origin in a profound, but as yet unexpressed new attitude on the part of a virile, agricultural people toward the universe. This profound, original feeling gives the bias to subsequent events throughout the life of the civilization. First, it manifests itself in great cathedrals and sculpture, next in painting, literature and music, followed by science, mechanics and wealth, and finally it manifests itself in dissolution, which comes because of a lack of faith in the worth-whileness of the original attitude toward the universe and because of disgust with the material results which have finally been inspired by that attitude. According to this analysis we have now come to the late fall, the eventide of this civilization, and the coming of the engineer is like the coming of Indian summer in late October just before the cold and dreary days of winter.

Philosophical analysis of this sort, even when backed up by archeological research, can of course be merely suggestive. But after our experience with the world war and the depression of the past four years, we are led to question the American credo, based as it has been on faith in progress unlimited, derived from endless mechanical invention, improved methods of mass production and ever-increasing profits. Without accepting either the implicit pessimism of the Spenglerian twilight philosophy or the Pollyanna optimism

[1] An address before the American Association for the Advancement of Science, Boston, Massachusetts, December 29, 1933.

of the old-fashioned American go-getter, I would ask you to examine superficially with me the contributions of science and engineering, the dilemma thereby created and a possible way out.

For one hundred years the productivity of the so-called civilized world has increased at the rate of about 3 per cent. annually. Correcting for increase in population, the output per capita has increased at the rate of about 1 per cent. annually. In the United States the rate of increase of material wealth has perhaps been a little faster than this. But everywhere there has been apparent a little slowing down during the world war and especially since 1930. And so we have, on the one hand, those people who proclaim that inevitably the pre-depression trend will be resumed, and those who, on the other hand, say that the time of the quantitative expansion of man's control over nature is now rapidly coming to a close.

Engineering and science, combined with the division of labor, have made it possible for an hour of man labor on the farm to produce several times as much as it did a hundred years ago. In company with the rest of you I have from time to time marveled over the tremendous contribution of the reaper, the binder, the combine, the truck, the tractor and the gang-plow, but inasmuch as we have now come to days of real soul-searching about all the things which we have hitherto called progress, I think it is high time for all of us to analyze these various labor-saving devices a little more critically. Do they really save as much as appears on first glance?

True it is that the farmer puts in only a mere fraction of his own labor in producing wheat, as compared with one hundred years ago, but what about the labor of the men who made the combines and the plows and the tractors? What of the labor of the men who transport the wheat the thousand miles to market, of the vast distributing and advertising machinery which seem to be necessary if we are to operate on the broad scale apparently required by the modern adaptations of engineering and scientific discoveries? Personally, I am inclined to think there is a real net gain, but it is a gain of a sort which can easily be lost altogether, unless certain social adaptations are very rapidly perfected.

The change from the back-breaking cradle of our forefathers to the modern combine ought to mean a tremendous release of human energy on the farm for something besides growing and harvesting a crop. The days when wheat was broadcast by hand, perhaps from a saddle horse, in retrospect seem quite romantic, but to the farmer who had to spend days at seeding-time where he now spends hours, the romance probably wore pretty thin. The grind of the harvest of years ago, the sweat of men in the fields and women in the kitchen, was an honorable thing, and even celebrated in song and story; but it didn't leave much time for living. The engineers and the scientists have given us the instruments and the methods whereby we can escape much of the grind; theoretically, there ought to be far more time for living and far more with which to enjoy life. Yet the reverse seems to be poignantly true.

The men who invented our labor-saving machinery, the scientists who developed improved varieties and cultural methods, would have been bitterly disappointed had they seen how our social order was to make a mockery of their handiwork. I have no doubt they felt they were directing their talents to free mankind from the fear of scarcity, from the grind of monotonous, all-absorbing toil and from the terrors of economic insecurity. Things have not worked out that way.

I do not mean to imply that there have been no gains. Of course there have been net gains, even if incommensurate with the hopes and promise of science. Plainly we must hold those gains, and add to them rapidly and extensively; but I think we can do this only if the planning of the engineer and the scientist in their own fields gives rise to comparable planning in our social world.

So far as science and engineering themselves are concerned, I see no reason why the rate of expansion which characterized the Century of Progress should not be increased, at least for a time. While there are certain ultimate limitations in our supplies of coal, iron, petroleum and soil fertility, it is obvious to most of us who are close to any particular phase of scientific research or technical organization that there are imminent discoveries which, when applied, will increase *per capita* output enormously. Nearly every technical man knows in his heart that from a purely scientific, engineering point of view the most amazing things could be done within a relatively short period. Of course, in the world of hard fact the full effect of any revolutionary invention is not felt typically for 15 or 20 years. But I feel safe in saying that our scientists and inventors to-day have enough new stuff within their grasp or just around the corner so that the world thirty years hence could easily have a total productive power twice that of to-day.

It is almost equally possible that the total wealth-producing power of the world a generation hence will be less than it is to-day. The trouble, if it comes, will not be in the inability of scientists and technologists to understand and to exploit nature, but in the ability of man to understand man and to call out the best that is in him. In solving this limitation the scientists and engineers have all too often been a handicap rather than a help. They have turned loose upon the world new productive power without regard to the social implications. One hundred years ago the power looms

of England destroyed the cottage weaving industry, and during the early years of that impact misery strode over the countryside of England in proportion as the nouveaux riches gained capital to exploit their gains over the entire world. That kind of thing has been done again and again, and we have called it progress because the power of man over nature was increasing and because in the long run the common man shared in this increase. What happened to the common man in the short run, of course, could be of no concern to a laissez-faire society.

Most of us, whether scientists, business men or laborers, have until recently looked back on the Century of Progress and called it good, but to-day the afflictions of Job have descended upon us and we must of necessity argue with Bildad, the Shuhite, and set ourselves right with our God before we go forward into a prosperity seven times that which we enjoyed before.

Acting perhaps in the capacity of Bildad, I would like to suggest that the very training which made possible the enormous material expansion of the past century may to some extent have made impossible the building of a just social system for the prompter and more uniform distribution of the wealth produced by the system. Most of the scientists and engineers were trained in laissez-faire, classical economics and in natural science based on the doctrine of the struggle for existence. They felt that competition was inherent in the very order of things, that "dog eat dog" was almost a divine command.

The power discovered by the scientist and inventors was applied in the United States by a race of men who had developed a concentrated individual willpower and an extraordinary thriftiness as a result of several generations of pioneer agricultural training and Protestant church-going. As a result, human power of high spiritual origin, but debased by the sophistication of the "devil take the hindmost" economics of the colleges, took command of the exploitation of the discoveries made by the scientists and inventors. The scientists and inventors have an intense kind of religion of their own—certain standards to which they like to be true—and as long as they could get enough money to pursue their researches, why should they care how some one else handled the social and economic power derived from these researches? Perhaps that is putting the matter unkindly, but other explanations that might be advanced are not much more flattering. Those who delved too deeply into social and economic problems got into trouble, and so many of the best scientists felt it was not good form to do things which to certain types of mentality seemed impractical and which might endanger the financial support of science.

It is my observation that previous to 1933 more than three fourths of the engineers and scientists believed implicitly in the orthodox economic and social point of view. Even to-day, I suspect that more than half of the engineers and scientists feel that the good old days will soon be back when a respectable engineer or scientist can be an orthodox stand-patter without having the slightest qualm of conscience. It is so nice to feel that there are great supermen from whom, directly and indirectly, you draw your own sustenance, who, sitting Jove-like above us lesser mortals, make possible the free functioning of the law of supply and demand in such a way that their profits enlarge at the same rate that our research expands. Like most of you in this audience, I rather like that kind of a world, because I grew up in it; in some ways, I wish we could get back to it. But both my mind and my instinct tell me that it is impossible for any length of time. Of course, if prosperity returns within the next year or two, it is possible for us to think that we are back in that old world again. But unless the people who make profits and direct capital allocation to different productive enterprises have seen a great light, or unless we move forward into certain highly centralized forms of industrial and governmental control, we shall sink back into our former trouble.

There ought to be more than a little hope, it seems to me, in the fact that our engineers have demonstrated so successfully their skill in planning. In many great industries, the engineers have been able to mark out the contours of expansion and development ten to fifteen years ahead. If in the past they seemed to be guided by purely material and mechanical considerations, that has doubtless been because such considerations were necessarily the chief ones so long as we were conquering a continent. To-day it is becoming increasingly evident that we must take into account the qualitative as well as the quantitative expansive aspects. This would suggest that in the engineering courses of the future the engineers should be given an opportunity really to enrich their minds with imaginative, non-mathematical studies, such as philosophy, literature, metaphysics, drama and poetry. Of course so long as an engineer is burdened with the necessity of putting in 18 hours a day mastering calculus, mechanics and the complex theories of electricity, he simply can not give any effective attention to the cultural aspects of life. And if by accident an engineer, exposed to studies of this sort, should be enthused by them, he might for the time being become somewhat less effective as an engineer. We are thus exposed to a dilemma, which I would be tempted to solve by saying that probably no great harm would be done if a certain amount of technical efficiency in engineering were traded for a somewhat broader base in general culture.

It is difficult to see how the engineer and the scientist can much longer preserve a complete isolation from the economic and social world about them. A world motivated by economic individualism has repeatedly come to the edge of the abyss, and this last time possibly came within a hair's breadth of plunging over. Yet science, all this time, has been creating another world and another civilization that simply must be motivated by some conscious social purpose, if civilization is to endure. Science and engineering will destroy themselves and the civilization of which they are a part unless there is built up a consciousness which is as real and definite in meeting social problems as the engineer displays when he builds his bridge. The economist and the sociologist have not yet created this definite reality in their approach; can you, trained in engineering and science, help in giving this thought a definite body?

To-day, when the industrial nations of the world have skimmed most of the cream off the backward nations and the backward classes and when there are no longer any challenging geographical frontiers to be conquered, it becomes apparent that we must learn to cooperate with each other instead of joining together in the exploitation of some one else. This means building a social machinery as precise and powerful as an automobile engine. How extraordinary is the patient vigor of thought which enables a group of engineers to blue-print and execute a new design. And how sloppy is our economic blue-printing and execution by comparison!

But it must be said in defense of the economists that their problem is infinitely more difficult than that of the engineer. The economic engineer has never had any excuse to exist until recently, because no one gave him any orders for blue-prints. Even yet the objectives are so loosely defined, the popular will is in such a state of flux, that the designing of the economic engineer is about like that of an automotive engineer who discovers after he has completed his engine that it was to go into a tractor instead of an automobile.

As I have said to many farm audiences, we are children of the transition—we have left Egypt, but we have not yet arrived at the Promised Land. We are learning to put off the hard-boiled language of the past, but we have not yet learned to speak the cooperative language of the future. One is as different from the other as a human being is different from an animal. There need be nothing impractical, there need be nothing foolishly idealistic about a Christian, cooperative, democratic state. But I fear it will take us as long to build a public consciousness fitted to run such a state as it is taking the Russians to build efficient factories and train their people to run them.

We know that there must be a balance between productive power and consumptive power, and that excessive profits used to expand productive power beyond consumptive power are sure to lead to a breakdown. We know that the continued insistence on heavy exports in excess of imports by a creditor nation is bound to lead to disaster. We know to-day that the great unemployment is in the so-called heavy industries, and that this could be remedied if faith in a profound new excitement swept the country like the railroad-building boom of the early eighties, or the automobile boom of the twenties. This boom might take the form of totally new railroad equipment, or the popularization of new and better airplanes, or the making fashionable of winter homes and winter industries for every one in the South and a duplicate summer set in the North. In any event, whatever is done to stimulate the heavy industries it is to be hoped that the bonds issued to pay for the stimulation will be on a long-term, amortized, low-interest basis.

We know that we must have a monetary system which will bring about a better balance between debtor and creditor and between productive power and consumptive power. These things can be measured and social machines can be built to deal with them, but before success can be expected, there must run through the rank and file of the people a feeling that amounts to a profound determination to deal with social problems.

There is something about engineering which tends to lay emphasis on logical, cold, hard, lifeless facts. Nearly all engineers have suffered the common punishment resulting from the remorseless discipline of higher mathematics, physics and mechanics. No man has to work as hard in college as the engineer. As a result, the engineer sometimes imputes a value to precise mathematical reasoning which it does not always have. There is such a thing as life, and the mathematics of life is as far beyond the calculus as the calculus is beyond arithmetic.

We can see in Mendelian genetics a complex algebra which has proved to be of some analytical use in determining the mechanism of heredity. Nevertheless, from the standpoint of producing superior plant and animal organisms, the engineering mathematical approach to life has not yet been especially successful. It seems to me that the emphasis of both engineering and science in the future must be shifted more and more toward the sympathetic understanding of the complexities of life, as contrasted with the simple, mathematical, mechanical understanding of material production.

The quantitative answers produced by the science of the past hundred years are not enough. They merely increase the speed of life without increasing the quality. Would that we had some one with the imagina-

tion of Sir Isaac Newton to develop the higher calculus of the engineering of life which is so necessary if our increased productive power is to increase total human happiness!

Haven't you sometimes wondered whether this whole Century of Progress might not be just a superficial and temporary phenomenon after all? The increase of physical output in three generations is so extraordinary that we've tended to think that this is what man is meant for. It seems to me a terribly inadequate yardstick of civilization. A man has food, clothing and shelter; wherein does he differ from the beasts of the field? Surely these are not the things which distinguish the civilized from the uncivilized. Food and shelter and the other necessaries in any rational order ought to go without saying. They ought to be as automatic and as universal, in this day of technological achievement, as the air we breathe. It is from this point on that life begins.

A characteristic of the engineer is his willingness to face the cold truth about the task to which he addresses himself. Engineers have brought to their jobs a more fully developed intellect than any other class of our citizenry. Sloppy, opportunistic thinking is simply inexcusable in the engineering world. I would be the last to suggest that the engineer abandon the precision of his thinking and his honesty in facing facts. I am merely asking that the same qualities be brought to bear in so far as possible on the more complex situations which have to do with living organisms and our social life. I fear, however, that in our social and economic life the objectives must always come from that mysterious realm which all engineers and scientists should treat with the greatest respect but with which engineering and scientific methods are totally unable to grapple.

In brief, then, we wish a wider and better controlled use of engineering and science to the end that man may have a much higher percentage of his energy left over to enjoy the things which are non-material and non-economic, and I would include in this not only music, painting, literature and sport for sport's sake, but I would particularly include the idle curiosity of the scientist himself. Even the most enthusiastic engineers and scientists should be heartily desirous of bending their talents to serve these higher human ends. If the social will does not recognize these ends, at this particular stage in history, there is grave danger that Spengler may be proved right after all, and a thousand years hence a new civilization will be budding forth after this one has long laid fallow in a relative Middle Ages.

SCIENTIFIC EVENTS

RADIO OBSERVATIONS OF THE ECLIPSE

ON February 14, 1934, a total eclipse of the sun will be available for observation, being total at noon on Wake Island in the Pacific Ocean. During the last total eclipse, August 31, 1932, radio observations of the ionization of the upper atmosphere (90 to 200 km above the earth's surface) were made by many observers, including J. T. Henderson and D. C. Rose[1] in Canada, H. R. Mimno and P. H. Wang,[2] G. W. Kenrick and G. W. Pickard,[3] S. S. Kirby and L. V. Berkner[4] in the United States, and T. R. Gilliland and K. A. Norton[4] at Sydney, Nova Scotia. An analysis of the results indicates that such observations determine the recombination coefficient of the ions in the upper atmosphere as well as the magnitudes and relative importance of the various ionizing forces in the upper atmosphere. The recombination coefficient was only approximately determined by the 1932 eclipse, while the results indicate that most of the ionization in the layers with maximum ionization at about 115 and 180 km was due to ultra-violet light from the sun. However, a small part of the ionizing force in the 115-km layer, and most of the ionizing force in the 220-km layer, were not eclipsed by the moon at the time of the normal light eclipse. A more acurate determination of the recombination coefficient and a further study of this non-eclipsed ionization would be of the utmost importance, shedding light on the constitution of the ionosphere and on the theories of the variations of terrestrial magnetism, etc. Recent technical advances[5] in radio methods of observation of the ionization of the upper atmosphere would greatly facilitate such observations. It is hoped that facilities for radio observations will accompany any expeditions for the observation of the February eclipse, since the conditions are peculiarly favorable to success, the sun being near the zenith and the date near a sunspot minimum. The success of radio observations, being independent of the presence of clouds, is a function only of the care with which preparations are made and the past experience of the observers.

Any observers must leave very shortly in order to be at the proper place in the Pacific in time for the eclipse work.

K. A. NORTON,
Junior physicist
U. S. BUREAU OF STANDARDS

[1] *Canadian Jour. of Research*, 8: 1–36, January, 1933.
[2] *I.R.E.*, 21: 529–546, April, 1933.
[3] *I.R.E.*, 21: 546–567, April, 1933.
[4] *Bureau of Standards Journal of Research*, December, 1933.
[5] T. R. Gilliland, *Bureau of Standards Journal of Research*, July and October, 1933.

THE COST OF GERMAN MEDICAL AND SCIENTIFIC PERIODICALS

DURING the past summer several conferences were held in Germany regarding the high cost of scientific and medical periodicals. One of the most important of these was held in Münster, during which the following groups met and decided to formally recommend fixed yearly prices, diminished content and at least a 20 per cent. reduction for the most expensive periodicals: The Verband der Deutschen Hochschulen, the Börsenverein der Deutschen Buchhändler, the Vereins Deutscher Bibliothekare and the Arbeitsgemeinschaft Wissenschaftlicher Verleger.

Dr. Ferdinand Springer and Dr. Herrmann Degener were present as delegates of the Börsenverein at a special committee meeting held in connection with the American Library Association meetings in Chicago on October 15. This was also attended by foreign delegates from the International Federation of Library Associations.

As the result of this conference and subsequent negotiations on the part of Charles H. Brown, chairman of the American Library Association Committee, and Mrs. Eileen R. Cunningham, chairman of the Medical Library Association, Dr. Springer announced an average reduction of 30 per cent. on his most expensive journals.

The Medical Library Association Committee called a special meeting of those medical librarians and members of Medical Library Committees present in Chicago, to consider the proposals of Dr. Springer, and, while they realized that this amount was not sufficient for a satisfactory permanent settlement, it seemed wisest to give Dr. Springer a certain amount of time in which to adjust matters and to enable him to carry out his promise that he would make every effort to reduce the price of all journals costing more than 60 RM a year published by his firm. If the German publishers are unable to fulfill their promise to go beyond the 30 per cent. reduction announced in the case of these very expensive journals it is certain that medical libraries, many of which are already laboring under terrific financial difficulties, will not be able to continue these journals. We hope that the proper measures will be taken to prevent such an outcome, and recent advices from Germany indicate that earnest effort is being made in this direction.

Since the return of Dr. Springer and Dr. Degener to Germany, a conference took place in Frankfurt between the officers of the Gesellschaft Deutscher Naturforscher und Aerzte and representatives of the Börsenverein der Deutschen Buchhändler and some of the most important scientific publishers. Those attending the conference agreed that while the Münster conference of August represented a good starting point, it was evident that further reductions would have to be made in those journals costing more than $40 a year and that every effort would be made by the German group to inaugurate these changes. An advance list of maximum prices for 1934 just received from Dr. Springer shows that in several instances he has been able to give better prices than the 30 per cent. indicated in Chicago. It is to be hoped that he and other German publishers will see their way clear to making some further reduction during the coming year, so that the scientific libraries of the world will still be able to continue their subscriptions to German scientific periodicals.

The Medical Library Association Committee will continue to function and the situation will be studied carefully during the next six months. Any new developments or further progress will be announced. For a detailed report of the work of the Committee on the Cost of Current Medical Periodicals of the Medical Library Association, see the *Bulletin* of the Medical Library Association, N.S., Vol. 22, No. 2, 1933.

EILEEN R. CUNNINGHAM,
Chairman

COMMITTEE ON THE COST OF
CURRENT MEDICAL PERIODICALS
MEDICAL LIBRARY ASSOCIATION

PROJECTS OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

THE Society for the Promotion of Engineering Education through its Division of Engineering Drawing and Descriptive Geometry is sponsoring a series of four projects which should be of interest to the engineering profession. They are:

1. A collection of material showing the evolution and variety of instruments used in engineering drawing.

2. A collection of old drawings intended to show the development of engineering drafting-room practise, covering as long a period of time as is possible. This exhibit will show the development of various means of reproduction on engineering drawings, which is closely related to changing drafting-room practise.

3. A collection of the work of writers, old and modern, on the subject of drawing and descriptive geometry.

4. The preparation of a series of bulletin board posters, carrying a portrait and biography of persons prominent in the history of engineering, and excerpts from their writings emphasizing the value to engineers of training in engineering drawing. Dexter S. Kimball, director of the College of Engineering at Cornell University, is arranging to display the various collections in connection with the annual meeting of the society to be held at Ithaca in the latter part of June, 1934.

The general development of the program is being directed by H. M. McCully, chairman of the drawing division of the Society for the Promotion of Engineering Education and head of the department of

engineering drawing at the Carnegie Institute of Technology. He is being assisted in this work by F. W. Ming, of the Brooklyn Polytechnic Institute, as chairman of a subcommittee having charge of the drawing instrument project; William G. Smith, of Northwestern University, whose committee will have the collection of historical types of drawings in charge; F. M. Porter, of the University of Illinois, whose committee will be in charge of the collection of the material showing the evolution of text-books on descriptive geometry, drawing and other forms of graphics. Mr. McCully is in charge of the collection of material for the posters.

Efforts are being made to interest the Rosenwald Museum of Industrial Art in Chicago in the collection of old forms of engineering drawing, to the end that such a collection may eventually become a part of their exhibits.

The bulletin board posters are intended for general distribution through the drawing departments of all the engineering colleges. They are to be posted week by week, and it is hoped that they will add an inspirational touch to the teaching program.

The chairmen of the various committees are very anxious to make their collections as complete as possible, and they request that any readers of this publication who are in a position to lend or contribute to any particular collection write to them at once stating the nature of their offering.

INORGANIC SYNTHESES

AT a meeting of a group of inorganic chemists at the Chicago convention of the American Chemical Society it was proposed that a series of volumes be published on inorganic syntheses somewhat similar to the organic syntheses now published. Like them, each synthesis submitted will be checked by another chemist before publication. The syntheses of each volume will be arranged in chapters on the basis of the periodic groups, with introductory chapters on special subjects. These syntheses will be either new, more efficient or simpler methods, older ones improved or ones which have been inadequately described when published in the journals.

Each synthesis will include precise directions with yields and purity of product as indicated by analyses. The method of analysis in cases where it is unusual will be described. Drawings may be used to simplify and to decrease length of descriptions. Sources of raw material where starting material is not on open market will be given. It is further expected that this will be an opportunity for original publication to supplement our crowded journals. The "Syntheses" will be abstracted in *Chemical Abstracts*. It is hoped that these volumes will aid in the renaissance of inorganic chemistry.

It is proposed to utilize any royalties to help defray the expenses of the secretarial help needed for the project. In order to get this project under way the following have been selected as a board of editors: L. F. Audrieth, W. C. Fernelius, W. C. Johnson, R. E. Kirk and H. S. Booth, editor-in-chief.

The board of editors will welcome contributions and wish that contributions would be sent in as soon as possible, as the assembly for the first volume is now under way. The board would also appreciate suggestions and comments on the plan.

MEDICAL LECTURES AT THE HARVARD AND STANFORD SCHOOLS OF MEDICINE

A SERIES of twelve public lectures on medical subjects will be given at the Harvard Medical School at 4 P. M. on Sunday afternoons, beginning January 7. The speakers, all but two of whom are members of the faculty of the school, and their subjects are:

January 7.—Dr. R. M. Smith, assistant professor of pediatrics and child hygiene, "How Do Your Children Grow?"

January 14.—Dr. F. W. Palfrey, assistant professor of medicine, "The Hygiene of Middle Life."

January 21.—Dr. T. B. Mallory, instructor in pathology, "Cancer."

January 28.—Dr. John Homans, assistant professor of surgery, "Varicose Veins and Varicose Ulcers."

February 4.—Philip Drinker, associate professor of industrial hygiene, "The Air We Breathe."

February 11.—Dr. F. T. Fulton, consulting physician at the Rhode Island and other hospitals and cardiologist at the Providence Lying-in Hospital, "How to Budget the Reserve Strength of the Heart."

February 18.—Dr. Walter Bauer, assistant professor of medicine, "Arthritis."

February 25.—Dr. V. H. Kazanjian, professor of clinical oral surgery, "Dentistry's Contribution to the Repair of Face and Jaw Deformities."

March 4.—Dr. W. L. Mendenhall, professor of pharmacology at Boston University Medical School, "Tobacco."

March 11.—Dr. Alice Hamilton, assistant professor of industrial medicine, "Dangerous Trades."

March 18.—Dr. F. C. Irving, professor of obstetrics, "The Change of Life."

March 25.—Dr. G. P. Grabfield, instructor in pharmacology, "Headaches and Headache Remedies."

The fifty-second course of popular medical lectures will be given by Stanford University School of Medicine on alternate Friday evenings at eight o'clock in Lane Hall from January 12 to March 23. The lectures and their subjects are:

January 12.—"The Organization of Medical and Surgical Emergencies in San Francisco," Dr. Edmund Butler.

January 26.—"Medicine in Community Service," President Ray Lyman Wilbur.

February 9.—"Relation of Diet to Health," Dr. Agnes Fay Morgan.

February 23.—"Occupational Therapy," Mary C. Rixford.

March 9.—"The Rôle of Psychiatry in Preventive Medicine," Dr. George S. Johnson.

March 23.—"Some Contributions of Medical Science to Our Knowledge of Pain," Dr. Joseph C. Hinsey.

OFFICERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A FULL account of the Boston meeting of the American Association for the Advancement of Science and the scientific societies associated with it, edited by the permanent secretary, will be published in the issue of SCIENCE for February 2. Officers of the association were elected as follows:

PRESIDENT

Professor Edward L. Thorndike, Teachers College, Columbia University.

VICE-PRESIDENTS AND CHAIRMEN OF SECTIONS

A—*Mathematics.* Professor R. D. Carmichael, University of Illinois.

B—*Physics.* Professor Henry G. Gale, University of Chicago.

C—*Chemistry.* Professor Joel H. Hildebrand, University of California.

D—*Astronomy.* Professor Frederick Slocum, Wesleyan University.

E—*Geology and Geography.* Professor James B. Macelwane, St. Louis University.

F—*Zoological Sciences.* Professor George L. Streeter, Carnegie Institution.

G—*Botanical Science.* Dr. Bernard O. Dodge, New York Botanical Garden.

H—*Anthropology and Archeology.* Dr. Melville J. Herskovitz, Northwestern University.

I—*Psychology.* Professor John E. Anderson, University of Minnesota.

K—*Social and Economic Sciences.* Carl Snyder, Federal Reserve Bank, New York.

L—*Historical and Philological Sciences.* Professor Solon J. Buck, University of Pittsburgh.

M—*Engineering.* Dr. C. E. Skinner, Westinghouse Electric and Manufacturing Company, East Pittsburgh.

N—*Medical Sciences.* Dr. Cyrus C. Sturgis, University of Michigan.

O—*Agriculture.* Professor Jacob G. Lipman, Rutgers University.

Q—*Education.* Professor Guy Thomas Buswell, University of Chicago.

ELECTED MEMBERS OF THE COUNCIL

Professor F. K. Richtmyer, Cornell University.
Dr. John C. Merriam, Carnegie Institution.

MEMBERS OF THE EXECUTIVE COMMITTEE

President Karl T. Compton, Massachusetts Institute of Technology.
Professor Edwin G. Conklin, Princeton University.

TRUSTEE OF SCIENCE SERVICE

Dr. J. McKeen Cattell.

SECRETARIES OF SECTIONS

I—*Psychology.* Professor John A. McGeoch, University of Missouri.

N—*Medical Sciences.* Professor Earl Baldwin McKinley, George Washington University Medical School.

SCIENTIFIC NOTES AND NEWS

THE Rumford Medal of the American Academy of Arts and Sciences was presented to Dr. Harlow Shapley, director of the Harvard College Observatory, at a joint meeting in Boston on December 27 of the academy and the American Association for the Advancement of Science. Dr. Shapley spoke on "The Anatomy of a Disordered Universe."

PRESENTATION of the Penrose Medal to Dr. Waldemar Lindgren, head of the department of geology at the Massachusetts Institute of Technology, was made on December 29 at the annual dinner of the fellows of the Geological Society of America. Professor Edson S. Bastin, head of the department of geology at the University of Chicago, in presenting the medal to Dr. Lindgren, pointed out that Professor Lindgren had brought his adopted country into a position of leadership in the science of ore deposits.

THE William H. Nichols Medal, bestowed annually by the New York section of the American Chemical Society, has been awarded for 1934 to Dr. Henry C. Sherman, Mitchill professor of chemistry in Columbia University. The award goes to Dr. Sherman for achievement in vitamin research, particularly in its quantitative aspects.

THE eleventh annual prize of $1,000, given by the American Association for the Advancement of Science to the author of a noteworthy paper presented at the winter meeting, was awarded at Boston to Dr. Reuben L. Kahn, professor of bacteriology at the University of Michigan Medical School, for his paper "Tissue Reactions in Immunity."

DR. WILHELM HIS, professor of internal medicine at Berlin, celebrated his seventieth birthday on December 29.

DR. A. FRANKLIN SHULL, professor of zoology at the University of Michigan, was elected president of the American Society of Naturalists at the semi-centennial anniversary meeting held in Boston on December 30.

OFFICERS of the Geological Society of America for 1934 are: *President,* William H. Collins, director of the Canadian Geological Survey; *Past president,* C. K. Leith, head of the department of geology, University of Wisconsin; *Vice-presidents,* Arthur L. Day, director, Geophysical Laboratory, Carnegie Institution, Washington, D. C.; Eliot Blackwelder, head of the department of geology, Stanford University; Percy E. Raymond, professor of paleontology, Harvard University; John E. Wolff, retired professor of petrography and mineralogy, Harvard University; *Secretary,* Charles P. Berkey, head of the department of geology, Columbia University; *Treasurer,* Edward B. Mathews, head of the department of geology, the Johns Hopkins University.

THE following officers were elected at the recent meeting in New York City of the Association for Research in Nervous and Mental Diseases: Dr. Theodore H. Weisenburg, of Philadelphia, *president;* Dr. Lewellys F. Barker, of Baltimore, and Dr. Clarence A. Patten, of Philadelphia, *vice-presidents,* and Dr. Thomas K. Davis, of New York, *secretary-treasurer.*

HOWARD COONLEY has been reelected to the presidency of the American Standards Association for the year 1934. Mr. Coonley is the president of the Walworth Company, New York, and also a director of several industrial, insurance and banking organizations. F. E. Moskovics, chairman of the board of the Marmon-Herrington Company of Indianapolis, and vice-president of the American Standards Association, was also reelected for the coming year.

DR. J. HAROLD WILLIAMS, professor of education at the University of California at Los Angeles, has been elected president of the Southern California Society for Mental Hygiene.

DR. RICHARD ATKINSON STONEY, Dublin, has been elected president of the Royal Academy of Medicine of Ireland, succeeding Dr. Thomas G. Moorhead.

DR. ROLLO C. BAKER, since 1927 associate professor of anatomy at the Ohio State University College of Medicine, has been appointed chairman of the department to succeed the late Dr. Francis L. Landacre.

DR. K. S. GIBSON has been appointed chief of the colorimetry section of the optics division of the Bureau of Standards to succeed the late I. G. Priest.

DR. F. L. DULEY, professor of soils at Kansas State College, Manhattan, has been appointed regional director of the Soil Erosion Service for the Limestone Creek Watershed in Jewell, Smith and Mitchell Counties, in northern Kansas.

DR. J. M. TINLEY, associate agricultural economist in the University of California, a member of the research and teaching staff of the Giannini Foundation of Agricultural Economics, has left for Washington, D. C., to aid in the national program of the dairy section of the Agricultural Adjustment Administration.

FRED W. PADGETT, professor of petroleum chemistry at the University of Oklahoma, has resigned to accept a position with the Sun Oil Company at Marcus Hook, Pennsylvania.

IRVING E. MUSKAT, research associate, is on leave from the University of Chicago and is engaged in research in organic chemistry at the Rockefeller Institute for Medical Research.

DR. OLIVER L. FASSIG, research associate of the Blue Hill Meteorological Observatory of Harvard University, is spending the winter in San Juan, Puerto Rico, at the School of Tropical Medicine, where he is carrying on meteorological investigations—a continuation of his researches on tropical climate.

DR. ALEXANDER G. RUTHVEN, formerly professor of zoology and director of museums of the University of Michigan, and now president, sailed from New York on December 12 for Europe, where he expects to inspect the several sites at which scientific expeditions of the university are at work.

DR. TRACY I. STORER, professor of zoology at the Davis branch of the College of Agriculture of the University of California, who has been given leave of absence for the spring semester, left on December 19 in order to make a study of wild life administration and control in European countries.

DR. WALTER B. CANNON, George Higginson professor of physiology at the Harvard Medical School, will deliver the annual Hodgen lecture of the St. Louis Medical Society on January 9. His subject will be "The Significance of the Emotional Level."

DR. ROBERT F. LOEB, associate professor of medicine at the College of Physicians and Surgeons, Columbia University, has concluded a visit to the School of Tropical Medicine, San Juan, Puerto Rico, where he delivered a series of lectures on "Edema and Its Treatment" and "Dehydration and Shock with Particular Reference to Adrenal Insufficiency."

DR. A. E. KENNELLY, professor of electrical engineering, emeritus, at Harvard University and the Massachusetts Institute of Technology, gave on December 8 the second in the series of Aldred Lectures at the institute. His subject was "The Relations of Engi-

neering to Our Modern World." On February 16, Dr. Harlow Shapley, director of the Harvard Observatory and member of the corporation of the institute, will give an illustrated lecture on "Engineering Problems and Practises in the Construction of Galaxies." This also is one of the Aldred Lectures.

DR. WILLIAM J. CROZIER, professor of general physiology and director of the Laboratory of General Physiology at Harvard University, will give a series of eight Lowell Lectures on "Mechanism and Behavior" in January, beginning on the fourth. The titles of the separate lectures are: "Elements in Behavior," "Tropistic Elements in Behavior," "Geotropic Conduct," "Variability in Behavior," "The Inheritance of Elements of Conduct," "The Combination of Tropistic Responses," "Analysis of Higher Behavior" and "Behavior and Natural History."

THE inaugural lecture by Professor P. M. S. Blackett, who was recently appointed to the university chair of physics in Birkbeck College, was entitled "Cosmic Radiation." The chair was taken by Lord Rutherford.

THE Sociedad Cubana de Historia Natural "Felipe Poey" has recently been reorganized after about five years of inactivity due to abnormal political conditions prevailing in that country. Meetings will be held as before at the Universidad Nacional in Havana, the first regular session being scheduled for January 15. Dr. Carlos de la Torre has been again elected president. Among other officers elected for the ensuing year are the following: *First Vice-president,* Dr. A. Mestre; *General Secretary,* Dr. Carlos Guillermo Aguayo; *Treasurer,* Miguel Jaume. *Directors of Sections: Mineralogy and Geology,* Dr. Santiago de la Huerta; *Biology,* Víctor Rodríguez; *Zoology,* Dr. Carlos de la Torre; *Entomology,* S. C. Bruner; *Paleontology,* R. H. Palmer; *Anthropology,* Dr. A. Mestre; *Agronomy,* Gonzalo M. Fortún; *Botany,* Brother León.

THE annual general meeting of the American Philosophical Society will be held on April 19, 20 and 21, beginning at 2 P. M., on Thursday, April 19.

THE forty-sixth annual meeting of the American Physiological Society, under the presidency of Dr. Arno B. Luckhardt, of the University of Chicago, will be held under the auspices of the College of Physicians and Surgeons, Columbia University, from March 28 to 31. The scientific meetings will be held in the Hotel Pennsylvania, which will also serve as headquarters. The demonstrations will be made at the College of Physicians and Surgeons. Dr. C. C. Lieb, 630 West 168th Street, is chairman of the local committee.

THE American Public Health Association will hold its sixty-third annual meeting in Pasadena, California, from September 3 to 6. The Western Branch of the American Public Health Association, with a membership of more than 1,200 from eleven western states, will hold its fifth annual meeting at the same time. Dr. J. D. Dunshee, health officer of Pasadena, has been appointed chairman of the Local Committee on Arrangements. He will be assisted by Dr. John L. Pomeroy, president, and Dr. W. P. Shepard, secretary of the Western Branch.

APPLICATIONS for positions of various grades in toxicology must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than January 11. At present there is a vacancy in the position of assistant toxicologist in the Bureau of Chemistry and Soils, Department of Agriculture, with headquarters in San Francisco. The entrance salary for this position ranges from $2,600 to $3,200 a year. Entrance salaries for all grades covered by the examination range from $2,600 to $5,400 a year, less a deduction of not to exceed 15 per cent. as a measure of economy and a retirement deduction of 3½ per cent. Competitors will not be required to report for a written examination, but will be rated on their education and experience. Certain specified education and experience are required.

THE Porter Fellowship in physiology of the American Physiological Society, established by Professor W. T. Porter, of Harvard University, will be continued for the year 1934–35. The candidate is to be appointed on the basis of research promise independent of the completion of advanced degrees. The proposed program of investigation is limited only by the general purpose of the fellowship, the pursuit of physiological research. The program submitted by the candidate must, however, be approved by the council. The stipend will be not less than $500 for the academic year. Further information can be obtained from Dr. Frank C. Mann, secretary, The Mayo Foundation, Rochester, Minnesota.

THE University of Buffalo announces a competition for its annual award of a gold medal to the author of a paper on an ophthalmologic or an allied subject. Dr. Harold W. Cowper, 543 Franklin Street, Buffalo, is chairman of the committee on award.

GOVERNOR LEHMAN, of New York State, has asked Dean Carl E. Ladd, of the New York State College of Agriculture, Cornell University, chairman of the Agricultural Advisory Commission, to take up with the federal authorities a suggestion that the Dutch elm disease in New York State be attacked with the aid of federal funds. Governor Lehman stated in his letter that there is every evidence that the disease spread rapidly in 1933 and that "immediate action is neces-

sary if we are to save the trees in this country." The Federal Government has made available $400,000 of Civic Works Administration funds with which to attack the disease up to May 1 next. Additional or other funds will be required after that. Governor Lehman urges that for the next two or three years, "or for such period as is necessary to determine the feasibility of eradication, the Federal Government continue to supply all funds necessary to adequately prosecute the complete eradication program."

DISCUSSION

WHAT ARE "EXPANSION" AND "CONTRACTION"?

IN a recent issue of SCIENCE (November 10, 1933), Dr. Mast takes exception to the terminology which I have proposed (September 29, 1933) to designate the movements of the pigment masses in the chromatophores of vertebrates and their changes in shape and apparent size. I proposed the terms "chromatosome," "melanosome," etc., for those pigment masses, and contended that the terms "expansion" and "contraction" be applied to these contained masses, rather than to the chromatophores themselves, to which many writers continue inconsistently to apply them.

Mast's account of the movements of the pigment granules back and forth along definite paths will hardly be disputed, at least for certain cases in which these phenomena have been carefully followed. We may also accept as probable his assertion that the source of the movement lies in the colorless cytoplasm, rather than in the granules themselves. His further reasoning, however, is difficult to follow. "While it is evident," he writes, "that the pigment masses (chromatosomes) change enormously in form, there is no evidence indicating that they *per se* change in size, *i.e.*, expand and contract, and that the change is due to processes within them." Again, "Under the conditions which induce movement of the pigment granules out into the branches of the chromatophores they become distributed through a relatively large space, and under those which induce movement in the opposite direction they become concentrated in a relatively small space."

I fail to see why Mast's account of what happens to the pigment granules in a chromatophore would not apply in its essentials to a volume of gas, subjected to variations in temperature or pressure. Here the molecules "become distributed through a relatively large space," or "become concentrated in a relatively small space," as the case may be. Yet no one hesitates to say that the volume of gas "expands" and "contracts." The same is true of liquids or solids, though within a much narrower range.

The fact that the pigment granules are suspended in hyaline protoplasm, and that this is (probably) responsible for their migrations, should not affect the issue. The "chromatosome," *i.e.*, the aggregate assemblage of pigment granules, does *expand* and *contract* in the same sense that a volume of gas expands and contracts. To say that the component particles "spread out" or "aggregate" is no more true in one case than in the other. But it is often convenient to avoid such circumlocutions, and to speak directly of what happens to the assemblage of particles. Is it not just as accurate to say that urethane, for example, causes "the chromatosomes to expand" as to say that this drug causes "the pigment particles in the chromatophores to spread out"? And is it not much simpler?

I can not, therefore, agree with Mast's contention "that the phrase 'expansion and contraction of these masses' (chromatosomes) describes the phenomena in question but little, if any, more accurately than the phrase 'expansion and contraction of chromatophores.'" If the words, as I have used them, are misapplied, it is likewise incorrect to speak of the expansion and contraction of the mercury in a thermometer or of the air in a tire-pump.

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CONVENTIONS OF BOTANICAL NOMENCLATURE

A RECENT article by Dr. R. W. Brown[1] is provoking in more senses than one; the sober admonition that "the botanists should now without hesitation follow the wise leadership of the zoologists" in a matter of nomenclature may well provoke the petty rage of *Fachleute;* it will provoke not only rage, but also attempts to answer and reflections on the nature of botanical nomenclature.

The field of systematic botany is cultivated by men of all nations; the fruit of their labor is intended for the use of all men, and all men are free to propose improvements in methods of cultivation. Dr. Brown urges at least four improvements: (1) The adoption of a standard system of pronunciation of scientific names; (2) the elimination of case-endings from personal names in specific epithets; (3) a new rule in codes compelling authors of names to supply the etymology; and (4) the decapitalization of all specific epithets.

Specific answers are to be derived from general principles. The names of plants are not code-designations arbitrarily established and subject to tinkering; they are words of a language, subject to the rules

[1] SCIENCE, 78: 333–335, 1933.

of grammar of the specific language and of language in general. As Latin, formerly the common language of scholars, has passed from use, scholars in most fields have ceased to possess a common language. If systematic botanists have clung to Latin, it is not because they are all prigs: we are not so silly as to pride ourselves upon a barbarous *Latina qui fecit tremblare pilastros.* We are glad to write in an ancient language, since then we can with justice insist that Italians and Dutchmen, Russians and Japanese write in a language which we can read. The fact that Latin is no longer a spoken language relieves us of the necessity of fixing the pronunciation.

Subject to the rules of Latin grammar, scientific names are bound by convention. By convention, any person is free to name an unnamed group; the name is applied and becomes binding by its publication together with a description, in Latin, of the group. The name is subject to various requirements which need not be retailed. Those familiar with the requirements, and with their operation, realize the futility of any attempts to restrict, more precisely than at present, the creation of names. We rely upon the goodwill of authors to explain their names; we can not reject the names if no explanation is forthcoming. In fact, we can not enforce under penalty the requirement of description in Latin, but must depend upon the conscience of every author. If some one violates the rule, he may expose any of us to the necessity of translating Danish or Portuguese. This insistence that there are botanists whose language is not English is not lightly to be brushed aside. I have seen a systematist compelled to find an interpreter of Japanese for a passage mistakenly supposed to describe a new group.

It is not by the rules of Latin grammar, but by convention, that the name of a plant is a proper noun, and that the name of a species consists of two words. The second word, in the names of most species, is an adjective; the term "specific name" as applied to most specific epithets is a misnomer, but a harmless one, creating no confusion in the minds of the instructed.

When, occasionally, the specific epithet is a noun in the nominative, it is in opposition with the generic name: *Robur, Cepa, Plantago-aquatica, Pecten-Veneris, Omorika* and *Mays* are usable by themselves as names of the species in whose full names they appear as specific epithets. By adoption into botanical Latin, the Slavic *Omorika* and the Indian *Mays* become proper names, as *Picea* and *Zea* are.

English grammar permits the use of naked nouns as adjectives. We speak of the Hoover administration or of the United States Geological Survey. Not so the Latin. In writing *Picea Engelmann,* one would imply that the name *Engelmann,* standing by itself, is usable as the name of a species of spruce.

All modern languages written in Roman characters distinguish in use between capital and small letters. Classic Latin did not make this distinction; in applying it to printed copies of Caesar's Gallic War, or to scientific names, we are necessarily guided by the usage of modern languages. Usage in all modern languages agrees that sentences and proper nouns begin with capital letters. It is as wrong to write *Michauxii* with a small initial as to apply the same treatment to United States Geological Survey.

Except as noted above, modern languages differ in the use of capitals; and in former years, botanical Latin published in different countries showed differences in the capitalization of proper adjectives. These differences have disappeared, in so far as the international character of systematic botany is appreciated, by compromise; personal adjectives are capitalized, geographical adjectives are not. This compromise has the usual weakness and strength of compromises. One may be jarred, at first, by seeing *californica* written with a small initial; but one realizes that if Germans do not insist on decapitalizing all proper adjectives, Americans need not insist on capitalizing all of them. A person who understands, and is not a hopeless non-conformist, soon becomes heartily reconciled to the system. One foolish individual protests that the state of California is far more important than any individual; another that capitalized specific epithets seem to mar the symmetry of a list. *De gustibus non est disputandum.*

About forty years ago, American systematists were engaged in a bitter dispute over rules of nomenclature. That controversy ended with a considerable body of American botanists defying the rest of the world to do its worst. By the experience of that time, we know that attempts to bring a strange harmony out of a confusion which is largely apparent create a confusion which is intolerable; also, that meddling with names does not clear the way for an interest in realities. On the contrary, it focuses attention on names. Still individuals are deluded by objectives which are neither feasible nor particularly desirable. The commonplace facts here stated seem adequate in answer to one such person. It has seemed worth while to repeat them, because the whole accepted system of botanical nomenclature is worthy of active support. It is not on the whole an arbitrary system; its arbitrary features (as in the capitalization of adjectives) are such as can be settled only arbitrarily; it is suited to the use of students who recognize an international public.

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AN AMENDMENT TO THE LAW OF MULTIPLE PROPORTIONS

THE chemist's law of multiple proportions, already defying succinct statement, demands a codicil, since even standard text-book problems may fail to meet the integral number test. It is possible to solve the familiar oxides of nitrogen problem correctly without obtaining values which stand to one another in the ratio of small whole numbers. The values so obtained, to be sure, bear a simple relationship to each other, but this relationship is neither necessarily obvious nor provided for by the law.

The five oxides of nitrogen obey the law when, as is usual, a definite weight of nitrogen is selected. If this weight is 28, the values for oxygen become 16, 32, 48, 64, 80, and stand to one another in the ratio of 1, 2, 3, 4, 5.

The same oxides fail to obey the law when a definite weight of oxygen is selected. If this weight is 16, the values for nitrogen become 28, 14, 9.33, 7, 5.6, and stand to one another in the ratio of the reciprocals of 1, 2, 3, 4, 5.

All that is needed, therefore, to make it effective is to amend the law of multiple proportions to read "the ratio of small integers or of their reciprocals."

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THE INDUCED OXIDATION OF LACTIC ACID BY ASCORBIC ACID AND THE CANCER PROBLEM

OUR researches on induced oxidation[1] and the earlier publications mentioned there have led us also to attempts to oxidize lactic acid.

The purpose of this investigation[2] was to find a method by which it might be possible to oxidize in cancer tumors the lactic acid formed there in large quantities, which acid is regarded by several authors as injurious to the surrounding cells and will perhaps further the extension of the tumor.

We observed that, for instance, sodium sulfite and also phosphorus (dissolved in castor-oil) are able to induce the oxidation of lactic acid during their own oxidation. For the above-mentioned purpose, however, our experiments with glucuronic acid and especially those with ascorbic acid (vitamin C) are promising.

In vitro a solution of lactic acid (the hydrogen ion concentration of which was brought by means of phosphate to the desired value) appeared to undergo a considerable oxidation in the presence of oxidizing ascorbic acid.

As vitamin C is a substance not strange to the human body (it is found in the adrenal cortex) and is being applied already as a remedy in connection with its anti-scorbutic activity, the question arises whether application *per os* or (and) by syringe could bring about salutary results in case of cancer.

As the oxidation of the ascorbic acid is reversible, it is possible that in the cells this substance may act as an oxygen carrier.

Of course, experiments with cancer cells cultivated in solutions and with tumors of mice are being made in the first place.

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REPORTS

THE EFFICACY AND ECONOMIC EFFECTS OF PLANT QUARANTINES IN CALIFORNIA[1]

THE appearance of Bulletin 553, of the Agricultural Experiment Station of the University of California, marks an important step in the study of the problems of plant quarantine. If it be not actually the very first attempt to evaluate these measures as they apply to any particular area, it is at least one of a very few such studies and by far the most comprehensive of all. In the words of the report, its scope is "the efficacy and economic effect of interstate plant quarantines promulgated by the State of California, and the efficacy of federal plant quarantines in the protection of California." Thus limited, the report avoids some of the most difficult problems, the "rather delicate subject" of the effect of these measures on international trade relations on the one hand and the absurdities of the inter-county quarantines on the other. Thus provided with a middle road to follow, the writers have been entirely consistent throughout and have held rigidly to the prescribed course.

The report includes a sound and reasoned statement of the biological bases of plant quarantines and throughout the necessity of compliance with these bases is insisted upon. An analysis upon theoretical grounds—which are the only ones available—is made of the economic effects of such measures. The history, problems and present status of plant quarantine

[1] *Rec. trav. chim.*, 48: 711–725, 1929.

[1] Report of a committee consisting of Harry S. Smith, *chairman*, Edward O. Essig, Howard S. Fawcett, George M. Peterson, Henry J. Quayle, Ralph E. Smith, Howard R. Tolley. University of California, College of Agriculture, Agricultural Experiment Station, Bulletin 553, pp. 1–276. 1933.

[2] *Chem. Weekblad*, 28: 337, 1931; 30: 618, 1933.

legislation in California are discussed. A review of the present interstate quarantines applying to California is presented, together with recommendations as to the maintenance or abolishment of each measure. There is an extensive bibliography and a thorough index.

It is an admirable report. Nevertheless the reader will do well to bear in mind the background from which it has emerged, not only as a justification for at times interpolating a bit between the lines, but as a basis for appreciation of what the committee has accomplished. The agricultural authorities of the state of California were pioneers in the development of the idea of plant quarantine and the application of quarantine legislation. As a result of years of such training faith has been deeply implanted and firmly rooted in the minds of California agriculturists that such measures are vital to their very existence. Under such circumstances, for an officially appointed California committee, composed of members who have imbibed a belief in quarantine almost with their mothers' milk, to have presented an unfavorable report would be almost unthinkable. On the other hand, it is a tribute to the intellectual honesty of the members of the committee that the reviewer—an avowed enemy of the quarantine system—can think of no critical phrase to apply to the report more condemnatory than "unduly cautious."

An uncompromising critic may be justified in pointing out that by the initial limitation of subject-matter the committee escaped the necessity of dealing with some disagreeable things and that in making their recommendations they have at times stopped somewhat short of entirely logical conclusions and have expressed themselves with much less emphasis than might reasonably have been employed.

For example: The principle that quarantines must depend upon natural barriers is definitely recognized (p. 94) in the remark that ". . . ordinarily a plant quarantine can be considered sound only when supported by an effective barrier to natural dispersal." It is clear that few existing interstate quarantines are supported in any considerable degree by such barriers. The logical conclusion that such quarantines should be placed in the hands of a federal agency and established along natural lines of defense rather than along purely artificial political boundaries is discussed (p. 117). But the committee goes no farther than to recommend (p. 253) that interstate quarantines be subject to review and disapproval by the Federal Secretary of Agriculture.

One other such case: The state of California has long maintained a quarantine against the alfalfa weevil, a quarantine that was not long since lauded by a former state director of agriculture as having stopped the insect at the state line. But the weevil has been found in California, widely distributed behind the quarantine lines and has probably been in the state for some time. It is evident that, coordinate with the quarantines, there should be set up an extensive and effective scouting service if the quarantines are not at times to assume a more than faintly ludicrous aspect. Attention is called to these circumstances (p. 136) and such a service is recommended, but not—in the reviewer's opinion—with the emphasis and prominence that would have been justified. In fact, one can not escape the feeling that the conspicuous failure of this quarantine, a failure that was inevitable and that now appears unimportant, has been "soft pedalled" just a wee bit in the report. It was an impossible quarantine to begin with and should frankly be jettisoned without the qualifying "if . . . within a few years . . ." (p. 197).

But criticisms such as this should not be allowed to detract from respect for the important work that the committee has done. Opponents of the quarantines at least can no longer say that no careful study has been made. Nor can they say that supporters of the quarantines never recommend the rescinding of a measure that has proven unnecessary. The committee has definitely recommended the abolition of three and is evidently lukewarm about some others. This is making progress.

Furthermore, the committee has recognized the need for deeper study of the problems of plant quarantine and has urged that such studies be made. Their report should serve as an excellent beginning, for they have touched in at least some degree upon practically every phase of the subject that one can suggest and have to at least some extent illuminated each.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR STUDYING DROUGHT RESISTANCE IN PLANTS

THE best measure of the drought resistance of a plant according to Maximov,[1] is its capacity to withstand permanent wilting. It is practically impossible to use this criterion for the study of drought resistance of plants having leathery, sclerophyllous or needle-like leaves. For conifers it is not only difficult to recognize the incidence of wilting but even impossible to determine the onset of death. Any one can

[1] N. A. Maximov, "The Plant in Relation to Water." Translated by R. H. Yapp. London, 1929.

readily distinguish between fresh flexible needles and dry brittle ones, but the determination of any definite intermediate stage is liable to great human error. It is desirable, therefore, to develop a method—which will be as free as possible from errors of human judgment—and which, furthermore, will subject the plants in question to a condition of drought somewhat similar to that encountered in natural habitats.

In temperate regions of average precipitation drought usually occurs in the form of a few days with hot dry winds, following a period of deficient rainfall. Accordingly, a simple machine was devised for subjecting plants to atmospheric drought. This consisted of a closed illuminated chamber inside which potted plants rested on a table revolving over trays of calcium chloride. Trials in this chamber gave gratifying results. The species supposed to be most drought-resistant endured longest in the drought chamber.

A more elaborate machine provided with temperature control was next constructed. This machine consists of an illuminated chamber with revolving table, through which air, dried by calcium chloride, is forced (Fig. 1). The desiccating chamber is illuminated by two 50-watt mill-type incandescent lamps. Dry air enters at the top, passing over wet- and dry-bulb thermometers and an electric heating element. The heating element is turned off and on by a toluene-mercury thermo-regulator operating through a 2-pole relay. A transformer 110–20 volts provides low voltage current for the mercury switch. The revolving table is supported by two opposed vertical and radial thrust type ball-bearings. Power is supplied by a one fourth horse-power motor through a reducing gear. Potted plants are placed on the revolving table, which has a 4-inch rim of 2-mesh hardware cloth. The table turns at the rate of 35 revolutions per minute. Access to the plant chamber is through a 12-inch door having a glass window.

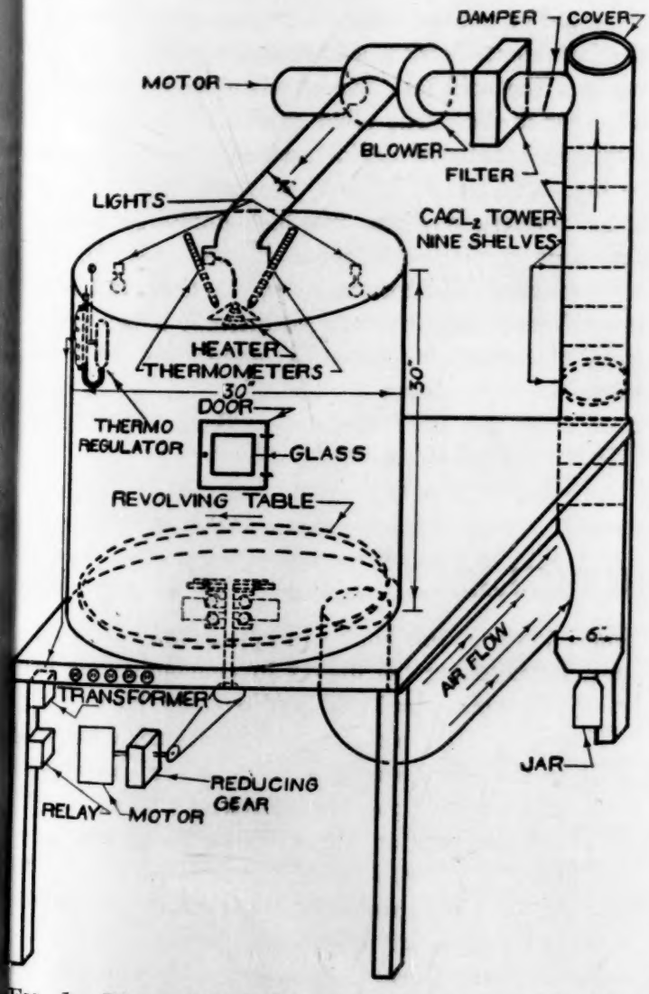

FIG. 1. Diagraphic drawing of apparatus for testing drought resistance.

After leaving the plant chamber the air enters the lower part of a tower containing nine wire shelves filled with calcium chloride. These shelves are supported on a rack, which may be removed bodily. Two racks of shelves are provided so that the calcium chloride may be quickly changed after it has absorbed too much moisture to function effectively as a desiccant. The tower, rack and trays are of copper. A removable glass jar is provided at the base of the tower for collecting dissolved calcium chloride. After leaving the tower the air passes through a filter of glass wool, thence through the blower and into the plant chamber.

The toluene thermo-regulator is sensitive to a change in temperature of a fraction of a degree and may be set for any value desired. The effectiveness of the calcium chloride in removing moisture from the air depends upon how dry the salt is. In its anhydrous form it is very effective. For rapidly moving air a large surface of the desiccant must be exposed. The air velocity is such that a complete air change occurs inside the chamber every 20 to 30 seconds.

It is assumed that the severity of the drought conditions is, with other conditions constant, a function of the evaporating power of the air or saturation deficit. Accordingly, most plants are tested at 35 to 40 degrees C., a temperature which the plants are apparently able to withstand, and which with low humidities gives a high saturation deficit.

The plants to be tested are weighed, selected for uniformity and potted in tin cans with a weighed amount of uniform fine sand. After allowing two to four weeks, or more, for the plants to become established, the cans are filled from below to a definite moisture content, sealed with paraffin and placed in the desiccating chamber. The machine is run con-

tinuously until all the plants are dead. The length of time each plant survives is used as a criterion of drought resistance, together with the moisture content of the soil at death. Ordinarily only a few plants remain alive until they have exhausted the soil moisture to critical values.

A description of a sample run follows. The plants tested were white spruce, *Picea canadensis,* of three different classes, *viz.:* 2–0 (two-year old seedlings), 3–0 (three-year old seedlings) and 2–1 (three-year old trees which have had two years in the seed-bed and one year in the transplant bed). Ten plants of each class were used. The temperatures averaged 38 degrees C. and the relative humidity about 10 per cent. The soil moisture at death was above 14 per cent. for all pots. The results are shown in Table 1.

TABLE 1

Class of stock	Number of days surviving	
	Mean	Standard error
2–0	20.2	1.2
3–0	21.4	1.5
2–1	13.2	.9

In this case the transplant stock proved to be far less resistant to atmospheric drought than either of the two classes of seedlings.

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A MODIFIED SABOURAUD MEDIUM SUITABLE FOR CULTIVATION OF ACID-FAST ACTINOMYCETES

THE study of five strains of Actinomycetes isolated at this hospital during the past four years from the blood of patients suffering both from acute and chronic ailments, has demonstrated the practical value of a simple medium such as Sabouraud's. By means of a modified formula for this medium one strain of Actinomycetes was found to be acid-fast, although it was non-acid-fast on such media as standard Bordet-Gengou, potato, synthetic phosphate and Difco Sabouraud.

The formula which we employ consists of 4 per cent. maltose, 1 per cent. Difco peptone, 1.8 per cent. flaked agar dissolved in unfiltered beef heart or veal infusion instead of water. No adjustment in reaction is made. Glycerine and other carbohydrates may be added if desired. Slanted agar favors development of acid fastness in about four days. A grayish brown powdery substance develops upon the upper portion of the slant simultaneously with the appearance of the acid-fast portions of growth.

The strain was isolated from the blood of a case of acute mastoiditis complicated by sinus thrombosis, septicemia and arthritis. The acid-fast component appeared in young cultures (seventy-two hours) on this medium as branching non-acid-fast mycelia containing acid-fast pleomorphic portions. Old cultures consisted of non-acid-fast oval components and mycelia interspersed with acid-fast oval-shaped components. The acid-fast characteristic was inhibited on all other media. The other strains of Actinomycetes were consistently non-acid-fast on all media employed so far.

Sabouraud's medium, in which unfiltered meat infusion is employed in place of water, is therefore recommended for cultivation of Actinomycetes isolated from human tissue. An attempt is being made to standardize this type of unadjusted unfiltered medium.

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SPECIAL ARTICLES

EXPERIMENTAL ANALYSIS OF VITO VOLTERRA'S MATHEMATICAL THEORY OF THE STRUGGLE FOR EXISTENCE

IN the last four years I have carried on an experimental investigation of the processes of the struggle for existence among unicellular organisms. Experiments on the competition between two species for a common place in the microcosm agreed completely with Volterra's theoretical equations, but as regards the processes of one species devouring another our results are not concordant with the forecasts of the mathematical theory. All this extensive experimental material is described in my book on "The Struggle for Existence," which is now ready for publication. Since, however, this book will appear only after some time, I am taking the liberty of communicating here briefly the main results of our investigations.

The competition between two species for a common place in the microcosm may be either (1) a competition for a certain fixed and limited amount of energy, or (2) a competition for a source of energy kept continually at a certain level. In order to investigate the first of these problems experiments were made with two species of yeast cells producing alcoholic fermentation: *Saccharomyces cerevisiae* and *Schizosaccharomyces kephir.* If we calculate the coefficients of multiplication in these species, and if by studying the factor which limits their growth (alcohol produc-

tion) we evaluate the coefficients of the struggle for existence (alcohol production per unit of yeast volume), and if we then correlate these parameters in the form of an equation of the struggle for existence given for the first time by Vito Volterra (1926) and slightly modified by Gause (1932), we shall obtain an agreement in general features with the observed growth of a mixed population.[1] Further experiments confirmed this conclusion and showed also that under slightly different conditions (a greater content of oxygen in the nutritive medium) the complicating effect of the by-products of fermentation decreases, and the forecasts of the theory coincide entirely with the values observed. In all these experiments we had to deal with the distribution of a certain fixed and limited amount of energy between two populations.

In order to investigate the competition between species for a source of energy kept at a certain level experiments were made with various protozoa, and very clear and convincing results were obtained for *Paramecium caudatum* and *Paramecium aurelia*. These infusoria were cultivated in a buffered balanced Osterhout's salt solution (pH = 8.0), in which a suspension was made of *Bacillus pyocyaneus* (of fixed density). It has been found that bacteria do not multiply under these conditions.[2] Every day infusoria were centrifuged, the nutritive medium changed, and every other day the microcosms underwent a cleansing process with a salt solution. Specially arranged experiments showed that the deficiency of food was the only limiting factor in these cases. We had under such conditions (a) a competition of *P. caudatum* with *P. aurelia* for the still unutilized food resources, but after the source of energy had been altogether taken hold of, we had (b) a redistribution of energy between two components which always resulted in a complete driving out of *P. caudatum* by *P. aurelia* (Fig. 1). All this agrees with the mathematical theory. The corresponding equations are somewhat complicated, because the coefficients of the struggle for existence vary with time: one species may be favorable for the growth of another at the beginning of the experiment, and the depression of one species by another will only begin later on.

The destruction of one species by another has been studied with *Paramecium caudatum* being devoured by another infusoria, *Didinium nasutum*. Experiments showed that this biological system presents no oscillations in the numbers of individuals peculiar to itself, and that in spite of abundant food for *Paramecium* the latter are completely destroyed by predators which perish in their turn later on. However, oscillations appear if we admit a controlled and simultaneous immigration of predators and prey into the

[1] Gause, *Jour. Exp. Biol.*, 9, p. 389.
[2] Johnson, *Physiol. Zool.*, 6, p. 22.

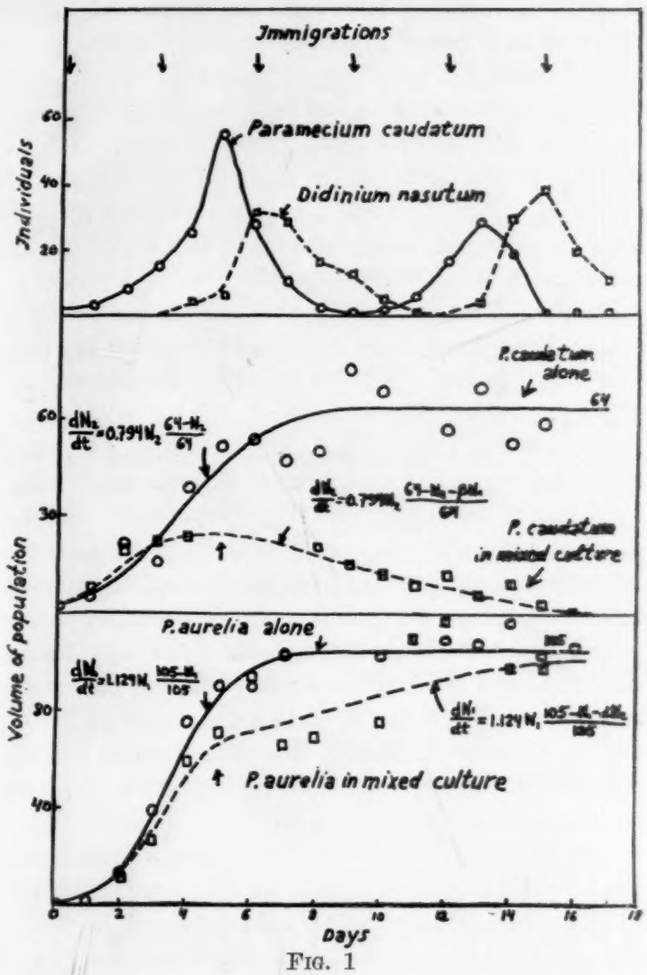

FIG. 1

microcosm. Therefore, it is not the interaction itself, as would be expected from the mathematical theory developed by Lotka (1920) and by Volterra (1926), but the constant interference from without that leads to the oscillation in numbers. The corresponding equation of the struggle for existence has no periodic solution. This is owing to the particular biological adaptations of our predators, which have not been foreseen in the theoretical equations. In our experiments an analysis was made of the rôle of cover or refuge for the prey in the processes of the struggle for existence. This showed that when the number of individuals becomes reduced, and the conditions in the microcosm complicated, instead of the "deterministic" processes subject to differential equations we are confronted with "probabilities of change" in one direction or another. The corresponding material will be found in the above-mentioned book.

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THE AMYLASE SYSTEM OF THE LIVER

COMPARISON of rat liver preparations, using the method for observing starch digestion introduced by Waldschmidt-Leitz and Samec,[1] showed that the

[1] *Zeitschr. für physiol. Chem.*, 203: 16, 1931.

amount of maltose formed at the blue-violet iodine endpoint in different preparations varies greatly. In a few cases, the iodine color endpoint was reached without any measurable maltose formation. This observation demonstrates, for the first time, that an amylase preparation can be made which in the early stages of starch digestion yields no reducing groups. This phenomenon is significant to the study of the constitution of starch.

Incubation of an aqueous liver suspension causes a considerable increase in its capacity to form maltose, while the iodine endpoint activity increases only slightly. In the centrifugate of such a preparation the comparative ratio of sugar formation to iodine end-point value is found to have shifted still further in favor of the sugar-forming component. Adding the resuspended residue to the centrifugate causes the latter to lose the increase in sugar formation observed in centrifuging, the iodine endpoint activity being practically unaltered throughout. The hypothesis, that there are two amylases with different characteristic maltose levels at the same iodine color endpoint, and an unstable inhibiting substance specific for the component showing more maltose formation, explains the observations here reported.

The inhibitor, soluble in fresh liver centrifugate, can be precipitated by treatment with acetic acid, pH 5.2, for 30 to 120 minutes. Resuspended in water, the precipitate can be redissolved by neutralizing, and in either state has a quantitative inhibiting effect on the formation of maltose from starch by liver preparations.

By treating fresh aqueous liver extracts with various concentrations of acetone, very stable amylase preparations have been made which show reproducible maltose formation at the iodine color endpoint at different levels, ranging from 3 to 15 mg per 100 mg starch. The conditions for producing fractions with a low sugar-forming level are very delicate, and have yet to be completely defined.

It is apparent that the digestion of starch by liver amylase, like that by plant amylase, is performed by two different components. Each component splits starch molecules in its own fashion, forming the fractions which make up the total course of carbohydrate breakdown.

The complete procedure and results of this study will be published in a later paper.

The author acknowledges indebtedness to Dr. Ellice McDonald for his valuable counsel and encouragement throughout this work.

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A CANKER AND GALL DISEASE OF GARDENIA[1]

A CANKER and gall disease has been observed to occur on the branches, stems and particularly the crowns of several varieties of Gardenia grown in greenhouses in the San Francisco Bay region in California. Infection apparently takes place only through wounds and most readily where the wounded part is near or in contact with the soil. On branches and stems not in contact with the soil the disease manifests itself as oblong cankers, frequently with the woody cylinder exposed at the point of infection and with the bark surface rough and corrugated. On infected crowns the cankers remain typical for a comparatively short time, after which they become overgrown with hypertrophied cortical tissue. This hypertrophy involves the entire circumference of the stem, increasing its diameter to twice normal or more and extending longitudinally one to two inches in both directions from the point of infection, giving the effect of an oblong gall. This abnormal swelling seems to be correlated with moisture, as it is apparent only where infected parts are in contact with the soil. In both cankers and galls the cortex is colored bright yellow a considerable distance in advance of the invading fungus. Pycnidia of the causal organism are found partially submerged in the cortical tissues surrounding the point of infection. Two types of spores exude in a short tendril from the same pycnidium. One, the A type, is hyaline, unicellular, elliptic-fusiform; mean size 3.4×9.7. The other, B type, is hyaline, unicellular, filiform, curved or flexuous; mean size 1.4×22.2.

The two spore types would indicate that the causal organism belongs in the genus *Phomopsis*. The fungus is readily isolated in pure culture both from spore tendrils and from tissue plantings of diseased parts. Inoculation of twigs and crown of Gardenia with this organism gave rise to typical cankers and galls from which the fungus was re-isolated and again successfully caused to infect Gardenia plants.

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[1] Contribution from the Division of Plant Pathology, University of California, Berkeley, California.

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